

The Weather Man : Forecasting Baryon Oscillations

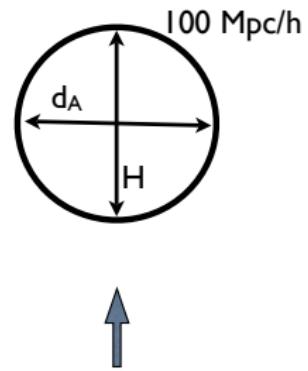
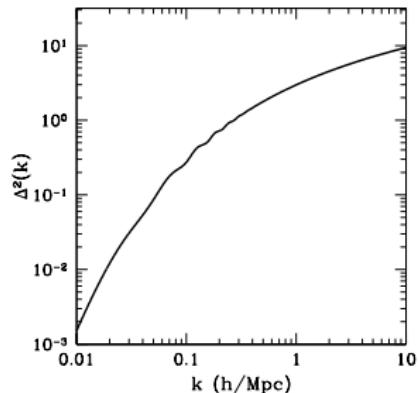
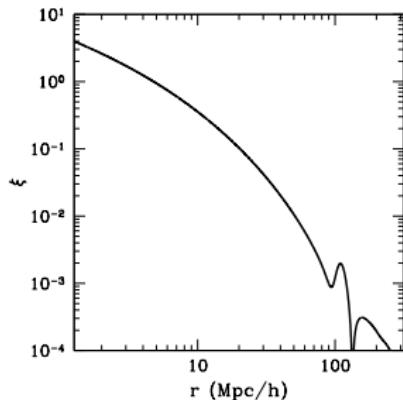
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w/ M. White, N. Mostek, A. Slosar

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BAO ... quickly

- Standard ruler imprinted by acoustic waves in the early Universe
- Probes both d_A and H
- Large scales - low systematics



Surveys

- Number density set by number of targets/sq. deg.; 2000/sq.deg
→ $\bar{n} = 3.4e - 4(h/Mpc)^3$
- Maximize clustering amplitude
- LRGs
 - ▶ Basis for SDSS, BOSS measurements
 - ▶ High bias; $b(0) = 1.7$; constant clustering with z
 - ▶ Well understood sample
- Emission line galaxies
 - ▶ Assume $b(0) = 0.8$; Sumiyoshi et al (astro-ph.CO/0902.2064)
 - ▶ Assume constant clustering amplitude
- Areal coverage
 - ▶ North = 14K sq. deg.
 - ▶ North + South = 24K sq. deg.

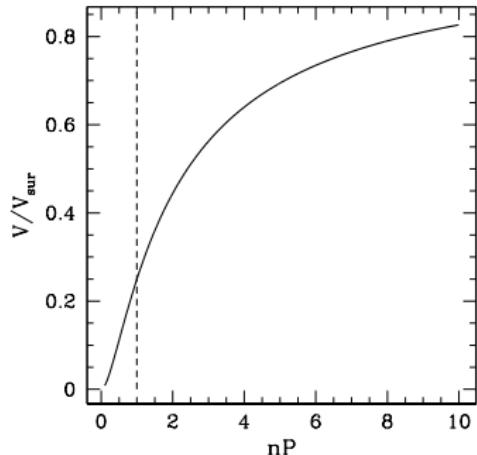
Three Metrics

- *Effective Volume*
- Distance Accuracies
- Dark Energy Parameters

Effective Volume

$$V_{\text{eff}} = \int \left[\frac{n(r)P(k)}{n(r)P(k) + 1} \right]^2 dV \quad (1)$$

- Depends on P_{gal} and \bar{n} ; maximize nP
- k dependent statement; assume $k \sim 0.2$
- Low nP : $V_{\text{eff}} \sim (nP)^2$
- High nP : $V_{\text{eff}} \sim V_{\text{survey}}$
- Saturation – no gain from increasing number density.
- *Caveat* : Reconstruction, cosmological parameters



A Worked Example

- $P(k = 0.2) = 1600 h^{-3} \text{Mpc}^3$
 - ▶ $b(z = 0) \sim 1$
 - ▶ Assume amplitude of clustering is non-evolving
- For BigBOSS ELGs, $\bar{n} \sim 3 \times 10^{-4} h^3 \text{Mpc}^{-3}$
- $nP \sim 0.5$
- For BigBOSS LRGs, $b(z = 0) \sim 1.7$, $nP \sim 1.5$
- Trimming to $z = 1.7$, $\bar{n} \times 1.5$ between 1.0 and 1.7.

A Worked Example, contd.

- $V(z = 1.0) \sim 50.0(\text{Gpc}/h)^3$
- $V(z = 2.0) \sim 200.0(\text{Gpc}/h)^3$
- $V(z = 3.0) \sim 370.0(\text{Gpc}/h)^3$
- What about QSOs?
 - ▶ $\bar{n} \sim 10^{-5}(\text{Mpc}/h)^{-3}$
 - ▶ $P(k)???$; $b(z = 0) \sim 1???$
 - ▶ $nP \sim 0.05$

Three Metrics

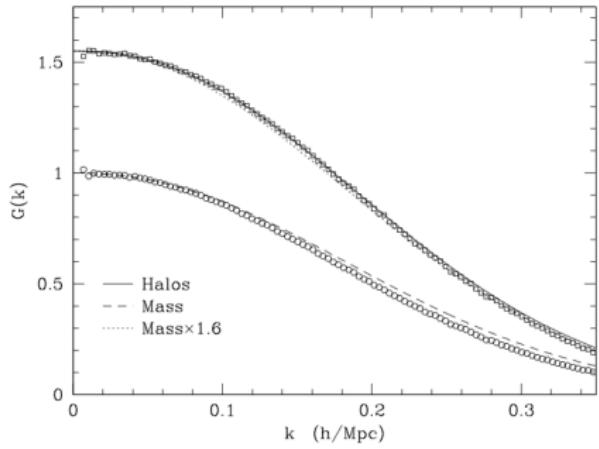
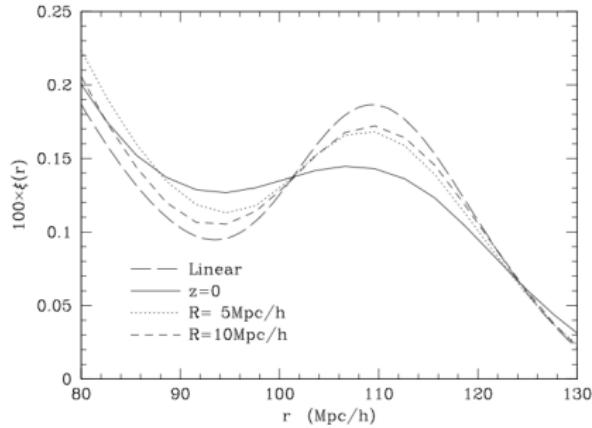
- Effective Volume
 - ▶ Model independent
 - ▶ Generic - for any $P(k)$ based measurement
 - ▶ k -dependent
- *Distance Accuracies*
- Dark Energy Parameters

Fitting the Acoustic Feature

- How well can we localize the acoustic feature?
- Marginalize over shape
 - ▶ Robust
 - ▶ Conservative
- Weight the different k bins by their expected signal
- What is the expected signal? What template do we use?
- $P_{\text{wiggle}} \exp(-k^2 \Sigma^2 / 2)$
- Smooths the correlation fn.
- Reduces distance accuracy.

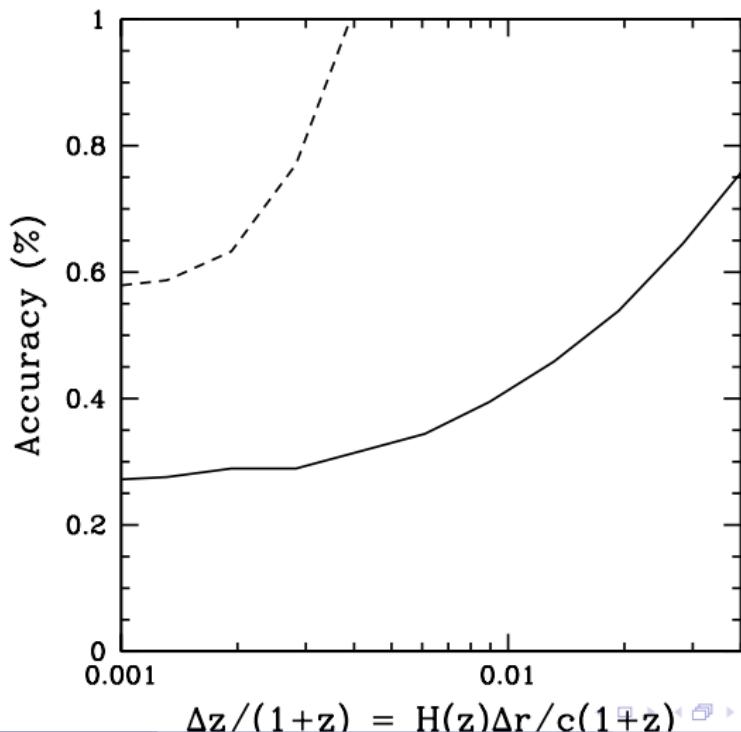
Σ : Physics

- Set by velocity flows
- $\Sigma \sim 10\text{Mpc}/h \times D(z)$
- Independent of halo bias



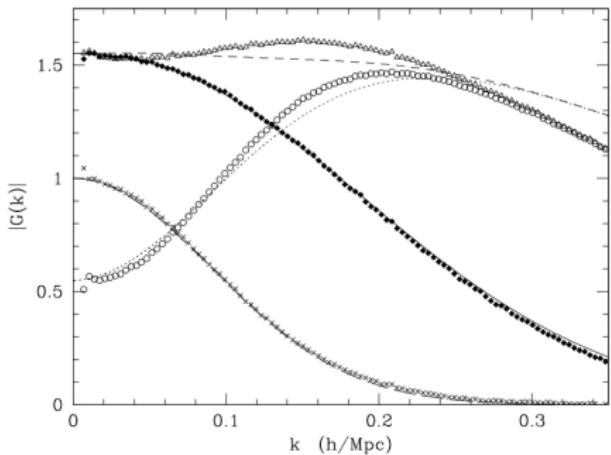
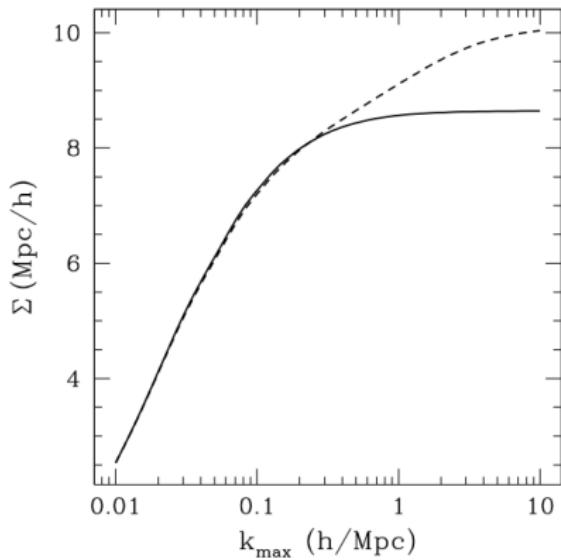
Σ : Measurements

- Redshift errors contribute to Σ in the z -direction



Reducing Σ : Reconstruction

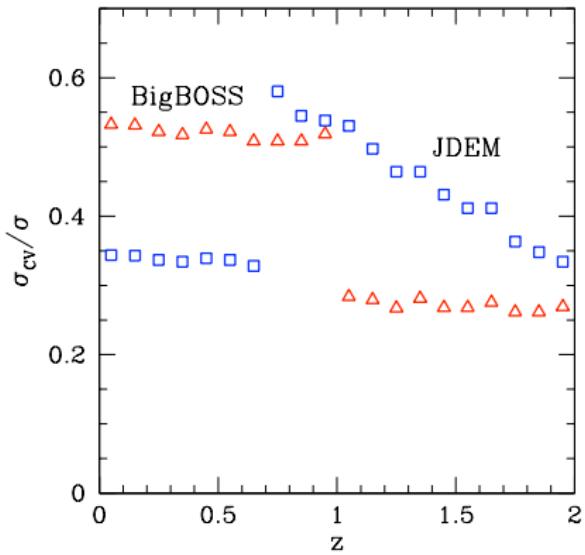
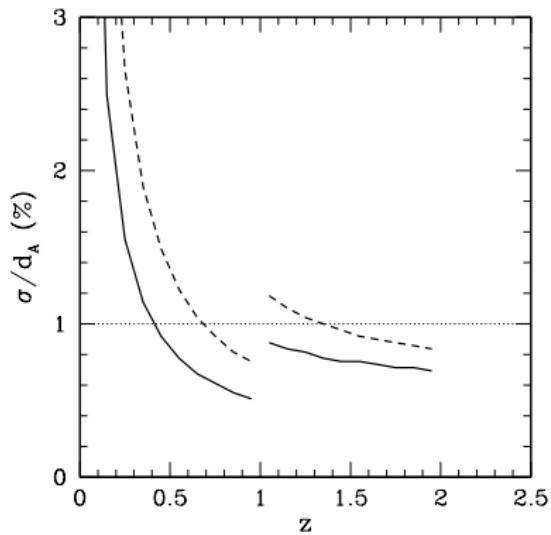
- Reverse large-scale flows



Eisenstein, Seo, Sirko, Spergel 2007
NP, White, Cohn 2009
Noh, White, NP 2009

Distance errors

- $\Delta z = 0.1$



Three Metrics

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 - ▶ Only BAO measurements
- Dark Energy Parameters

Three Metrics

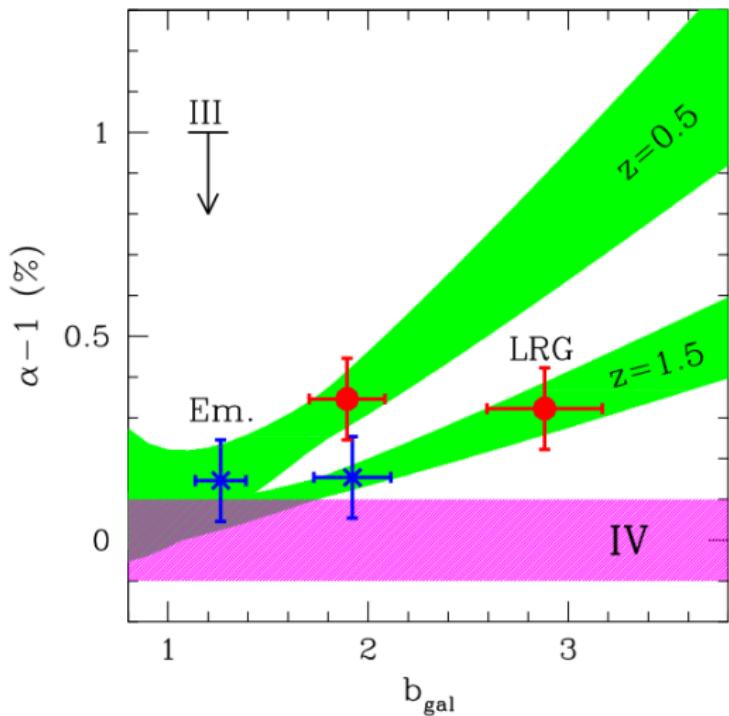
- Effective Volume
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 - ▶ Only BAO measurements
- Dark Energy Parameters
 - ▶ Model dependent
 - ▶ Prior dependent
 - ▶ Planck usually assumed (but not necessary)

Putting it all together

	BOSS (Stage III)	BigBOSS-North (Stage IV)	JDEM BAO (Stage IV)	BigBOSS-N+S (Stage IV)
Redshift range	$0 < z < 0.7$	$0 < z < 3.5$	$0.7 < z < 2.0$	$0 < z < 3.5$
Sky Coverage	10000 deg ²	14000 deg ²	20000 deg ²	24000 deg ²
Wavelength Range	360-1000 nm	340-1130 nm	1100–2000 nm	340nm–1130 nm
Spectral Resolution	1600-2600	2300-6100	200	2300-6100
DETF FoM	57	175	250	286
DETF FoM w/Stage III	107	240	313	338

Systematics

- Nonlinear clustering
- Galaxy bias
- Redshift space distortions
- These appear to be under control.



NP, White, 2009

Your Seven Year Forecast

- Different metrics have different emphasis
- We are sensitive to assumptions
- We need \bar{n} , b – forecasts only as good as assumptions!
- Systematics under control